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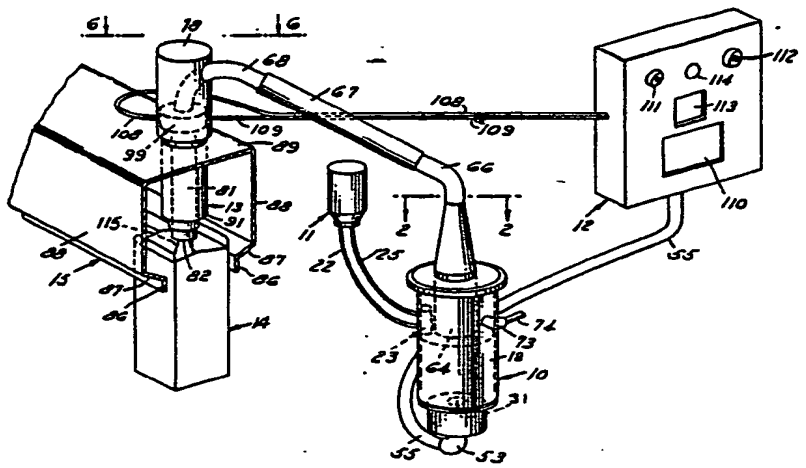

(57) Abstract

A method and apparatus for applying a bactericide aerosol to a container (14) for sterilization of the same. A reservoir (11) feeds a liquid bactericide into a nebulizing chamber (17) in which is operatively mounted a transducer (31) that is energized by high frequency electrical power for producing vibrational energy for directly energizing the bactericide to nebulize the liquid bactericide into fine particles. A source of pressurized air is connected to the nebulizer to provide a carrier air for conveying the fine particles of bactericide through a transfer tube (67) to a heated nozzle (13) for spraying the fine particles into a container. A monitor (12) is operatively connected in the flow path of the bactericide aerosol for monitoring the flow rate of the bactericide aerosol. By virtue of this invention, improved control of the creation and concentration of a bactericide aerosol is attained, whereby complete sterilization is assured.

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METHOD AND MEANS FOR APPLYING BACTERICIDE TO CONTAINER FOR STERILIZATION

TECHNICAL FIELD

This invention relates generally to the sterilization of containers used in a packaging machine, as for example, containers employed in the packaging of homogenized milk, buttermilk, skim milk, eggnog and the like. The invention is particularly concerned with an improved method and means for generating and applying a bactericide aerosol to containers as they are conveyed through a packaging machine, and for monitoring the flow rate of the bactericide aerosol.

BACKGROUND ART

It is known in the industrial field to employ the use of bactericide for sterilizing containers in the carrying out of packaging procedures. This is presently accomplished through the use of an atomizing nozzle being fed with bactericide by a pressurized reservoir tank and with the flow being monitored with an electric flow meter, such as a Rampo.

However, a disadvantage of the aforecited atomizing nozzle apparatus is that such apparatuses are not capable of producing fine particles of a bactericide aerosol and with an optimum high output of the same. A further disadvantage of said prior art atomizers is that they are not capable of providing an optimum homogenous mixture of particles of bactericide with a carrier gas thereby providing complete coverage of the inside of a container, and doing it in a fast manner and with complete dissipation of the bactericide

aerosol before filling of the container. A still further disadvantage of said prior art atomizers is that they are not monitoring the flow of the aerosol bactericide, but rather the flow of the liquid bactericide.

It is also known in the medical art to employ ultrasonic nebulizers for various purposes, both for hospital and home use for respiratory therapy. An example of an ultrasonic nebulizer employed for respiratory therapy applications is an ultrasonic apparatus available on the market from the DeVilbiss Company, Somerset, Pennsylvania, 15501, and identified as Model 65, and which is disclosed in United States Patent No. 3,387,607.

A disadvantage of the aforementioned DeVilbiss type nebulizer is that the transducer employed in the same does not directly apply vibrations to the liquid bactericide, but transmits the vibrations through an intermediate medium which results in low efficiency and loss of energy. A further disadvantage of said prior art nebulizer is that it does not provide any means for monitoring the aerosol.

DISCLOSURE OF THE INVENTION

The present invention provides a new method and means for introducing a bactericide aerosol into a container for sterilizing the container as a step in the packaging process carried out by a packaging machine.

The apparatus for carrying out the method of the present invention includes an ultrasonic nebulizer including a body portion having a closed nebulizing chamber for holding a predetermined amount of a liquid bactericide, such as hydrogen peroxide. A piezoelectric transducer is operatively mounted in the nebulizing chamber for direct contact with the bactericide. The transducer is energized by a high-frequency electrical power supply for generating vibrational energy and transmitting it directly to the liquid bactericide to nebulize it into fine particles.

The chamber is provided with an inlet port for admitting carrier air under pressure for mixing with the fine particles of bactericide to form a bactericide aerosol. The nebulizing chamber is provided with an exhaust pipe

having an inlet end disposed in alignment with the transducer. The carrier air inlet port is disposed above the inlet end of the exhaust pipe so that the carrier air enters the exhaust pipe in a concentric manner relative to a geyser of said fine particles to provide an optimum homogenous mixture or aerosol of said particles with said air.

The exhaust pipe is connected to a nozzle means for spraying the bactericide aerosol inside of a container. The nozzle means is heated to prevent the coalescence of said particles back into drops of bactericide. The nozzle means is heated in one embodiment by a hot air means, and in another embodiment by an electric heater means. A reservoir means is operatively connected to said nebulizing chamber for supplying liquid bactericide to said chamber and maintaining a predetermined level of said bactericide in the chamber.

An electric-eye monitoring means is operatively mounted in the flow path between the nebulizing chamber and the nozzle means for monitoring the flow rate of bactericide aerosol flowing into the nozzle means.

Other features and advantages of this invention will be apparent from the following detailed description, appended claims, and the accompanying drawings.

BRIEF DESCRIPTION OF DRAWINGS

Fig. 1 is a schematic view of an apparatus for applying bactericide to containers for sterilization of the same, and made in accordance with the principles of the present invention.

Fig. 2 is a top plan view of a part of the structure illustrated in Fig. 1, taken along the line 2-2 and looking in the direction of the arrows.

Fig. 3 is an elevation section view of the structure illustrated in Fig. 2, taken along the line 3-3, and looking in the direction of the arrows.

Fig. 4 is an elevation view, partly in section, of the structure illustrated in Fig. 3, taken along the lines 4-4 thereof, and looking in the direction of the arrows.

Fig. 5 is a fragmentary, horizontal section view of the structure illustrated in Fig. 3 taken along the line 5-5 thereof, and looking in the direction of the arrows.

Fig. 6 is a fragmentary top plan view of the structure illustrated in Fig. 1, taken along the line 6-6 thereof, and looking in the direction of the arrows.

Fig. 7 is an elevation section view of the structure illustrated in Fig. 6, taken along the line 7-7 thereof, and looking in the direction of the arrows.

Fig. 8 is a fragmentary, side elevation view, partly in section, of the structure illustrated in Fig. 7, taken along the line 8-8 thereof, and looking in the direction of the arrows.

Fig. 9 is a horizontal section view of the structure illustrated in Fig. 8, taken along the line 9-9 thereof, and looking in the direction of the arrows.

Fig. 10 is a top view similar to Fig. 6, of a modified electric heater means employed in the invention.

Fig. 11 is an elevation section view of the structure illustrated in Fig. 10, taken along the line 11-11 thereof, and looking in the direction of the arrows.

Fig. 12 is a horizontal, enlarged section view of the structure illustrated in Fig. 11, taken along the line 12-12 thereof, and looking in the direction of the arrows.

Fig. 13 is a fragmentary, side elevation view, partly in section of the structure illustrated in Fig. 11, taken along the line 13-13 thereof, and looking in the direction of the arrows.

Fig. 14 is an enlarged, horizontal section view of the structure illustrated in Fig. 13, taken along the line 14-14 thereof, and looking in the direction of the arrows.

BEST MODE FOR CARRYING OUT THE INVENTION

Referring now to the drawings, and more particularly, to Fig. 1, the numeral 10 generally designates a nebulizing chamber made in accordance with the principles of the present invention, and which is adapted to nebulize a suitable liquid bactericide into fine particles. Fig. 1 shows a schematic arrangement of the apparatus of the present invention for not only producing said fine particles of a of a bactericide, but also means for mixing same with a pressurized flow of carrier air and means for applying the

bactericide aerosol so formed to containers as they are processed in a packaging machine. Fig. 1 also generally illustrates a means for monitoring the flow rate of the bactericide aerosol.

The numeral 11 in Fig. 1 generally designates a reservoir for a liquid bactericide, such as hydrogen peroxide. The reservoir 11 may be of any suitable structure and shape, as for example, it may comprise a bottle type reservoir. The numeral 12 in Fig. 1 generally designates an electrical control unit for monitoring the flow rate of bactericide aerosol as it passes through a heated nozzle, generally indicated by the numeral 13, and producing high frequency impulses.

As shown in Fig. 1, the heated nozzle 13 is adapted to introduce the bactericide aerosol into a container, generally indicated by the numeral 14, as it passes through a conventional long hood structure, generally indicated by the numeral 15, which maintains a sterile condition in that portion of the packaging machine.

As shown in Figs. 1 and 4, the nebulizer 10 includes an elongated cylindrical chamber wall 18 in which is formed a cylindrical nebulizing chamber 17. As shown in Fig. 3, the chamber bottom end wall 19 is secured to the cylindrical wall 18 by any suitable means, as by welding. The chamber 17 is adapted to be normally filled to a predetermined level with hydrogen peroxide 20, as for example, to a predetermined, constantly maintained level of about 2-1/2" of hydrogen peroxide above the inner face of the bottom end wall 19. The hydrogen peroxide 20 is conducted from the reservoir 11 by a suitable flexible tube 22 which conveys the hydrogen peroxide into a conventional liquid level control unit, generally indicated by the numeral 23. .The liquid level control unit may be of any suitable type, as for example, the type disclosed and employed in the aforecited DeVilbiss nebulizer. The liquid level control unit 23 is provided with an outlet pipe 24 for admitting hydrogen peroxide, or other suitable bactericide, into the chamber 17. A flexible, large-diameter tube 25 also connects the liquid level control

unit 23 with the reservoir 11 to provide a closed supply circuit. When the liquid level in the chamber 17 falls, air flows through the large diameter tube 25 into the reservoir 11 and allows more liquid bactericide to flow through the small-diameter tube 22 into the chamber 21.

As shown in Fig. 3, a centrallly disposed, stepped diameter bore 28 is formed through the chamber bottom end wall 19. A suitable piezoelectric ultrasonic transducer 31 is seated in the bore 28, between a pair of suitable O-ring seals 32 and 33. The transducer 31 is held in position in the bore 28 by a suitable retainer ring 34 which is held in place in the wall 19 by a suitable cover plate 35 which is releasably secured in place by a plurality of suitable machine screws 36. The transducer 31 is connected by suitable lead wires 37 which pass through a suitable opening in the plate 35 and which are connected to a terminal strip 40.

As shown in Figs. 3 and 5, the terminal strip 40 is secured by suitable screws 39 to the inner face of the bottom end wall 41 of a cylindrical housing formed by a cylindrical wall 42. The lower end of the housing wall 42 is secured to the end wall 41 by any suitable means, as by welding. The cylindrical wall 42 is provided on its upper end with an integral, outwardly extended flange 43. The flange 43 is attached by suitable machine screws 44 to the housing bottom end wall 19. A suitable ring seal 45 is disposed between the flange 43 and the chamber end wall 19.

As shown in Fig. 3, the nebulizer 10 is provided with a liquid level float switch, generally indicated by the numeral 46. The float switch 46 includes a cylindrical float member 47 which is movably mounted on a vertical post 48. The post 48 is operatively supported by a pipe fitting 49 which is threadably mounted in a threaded hole 50 formed through the end wall 19. The float switch 46 is a safety apparatus which allows the nebulizer 10 to operate only when the float 47 is in the raised position shown in Fig. 3. If the level 20 of the hydrogen peroxide falls below a safe level, the float 47 falls and makes a contact to energize the warning light 114 on the control unit 12,

and the nebulizer 10 is automatically shut off to prevent internal damage to the nebulizer. It will also be understood that the safety switch 46 would be connected by suitable circuitry to the controls of the packaging machine when the switch 46 is energized.

The switch 46 is connected by suitable lead wires 51 to the terminal strip 40. The lead wires 52 indicate suitable lead wires for connecting the transducer 31 and the safety switch 46 from the terminal strip 40 to the control unit 12. The last mentioned lead wires 52 would be conducted through a suitable electrical conduit 55 to the control unit 12. As shown in Fig. 3, the conduit 55 is connected to the nebulizer unit 10 through a suitable conduit elbow 53 which is threadably mounted in a threaded hole 54 in the housing end wall 41. As shown in Fig. 5, the nebulizer 10 is provided with a ground wire 56 which is secured to the housing end wall and which passes through the conduit 55 to a suitable ground source.

As shown in Fig. 4, the nebulizer 10 is provided with an overflow pipe 58 which extends through a suitable hole in the cylindrical wall 18 to a pipe elbow 59. The pipe elbow 59 is connected to a suitable pipe 60 for connecting the overflow pipe 58 to a suitable drain.

As shown in Figs. 2, 3 and 4, the upper end of the nebulizer chamber 17 is enclosed by a top end wall cover 63 which is secured in place by a circular attachment ring 61. A suitable ring seal 69 is mounted between the upper end of the cylinder wall 18 and the lower side of the top end wall cover 63. As best seen in Figs. 2 and 3, the nebulizer 10 is provided with a pair of suitable mounting arms 62.

As shown in Figs. 3 and 4, the nebulizer 10 includes a centrally disposed exhaust pipe 64 in the chamber 17. The pipe 64 extends through a suitable hole 70 through the end cover 63 and it is secured to the cover 63 by any suitable means, as by welding. The lower end 65 of the pipe 64 is open, and it is spaced a predetermined distance upwardly from the surface 71 of the hydrogen

peroxide 20 in the chamber 17. As shown in Fig. 4, the pipe 64 extends upwardly from the top end wall 63 and terminates in a sideward sloping, reduced diameter top end 66. As shown in Fig. 1, the upper end of the pipe 66 is connected by a suitable transfer tube 67 to the inlet end of a goose-neck shaped pipe 68 which forms a supply conduit for the heater nozzle 13.

As shown in Figs. 2 and 4, the nebulizer 10 is provided with a threaded inlet port 72 which is formed through the cylindrical chamber wall 18, at a point spaced upwardly from the lower end 65 of the exhaust pipe 64. A pipe elbow 73 is threadably mounted in the port 72. As shown in Fig. 1, the pipe elbow 73 is connected to a pipe 74 which would be connected to a suitable source of air under pressure. As illustrated in Figs. 3 and 4, the air under pressure supplied to the nebulizer 10 through the inlet port 72 passes downwardly, and then up and into the exhaust pipe 64 to pick up the fine atomized particles of hydrogen peroxide, and carry them overto the heated discharge nozzle 13. The transducer 31 vibrates the hydrogen peroxide to produce fine particles of the hydrogen peroxide which are raised above the surface 71 of the hydrogen peroxide to form a pyramid type configuration of fine particles, or geyser, as indicated in Figs. 3 and 4 by the numeral 84. It will be seen that the carrier air entering the port 72 is directed downwardly, and completely around the lower open end 65 of the pipe 64, so as to bring the carrier air into the pipe 64 in a concentric manner around the geyser 84 and provide for an optimum pick-up action by the carrier air of the fine particles of hydrogen peroxide.

As shown in Fig. 7, the nozzle supply pipe 68 is mounted through a hole 77 formed through the side wall of a cylindrical cover member 78, which is enclosed by an end wall at its upper end. The pipe 68 is fixed to the cover 78 by any suitable means, as by welding. As shown in Figs. 6 and 8, an attachment screw 76 is threadably mounted at its lower end in an electric eye assembly, generally

indicated by the numeral 99. The upper end of the attachment screw 76 passes through a suitable hole formed through the top end wall of the cover 78, and the cover 78 is secured to the attachment screw 76 by a suitable wing nut 75.

As shown in Fig. 6, the electric eye 99 includes a substantially circular mounting block comprising a pair of interfitting parts 97 and 98. As shown in Fig. 7, an axially extended flange on the lower side of the electric eye mounting block formed by the parts 97 and 98 forms a recess 101 which receives the upper end of a tubular heating chamber member 91 for the nozzle 13. The electric eye mounting block parts 97 and 98 are fixedly secured together, and to the upper end of the nozzle tubular heating chamber member 91 by any suitable means, as by welding. An axial bore 116 is formed through the electric eye mounting block structure formed by the parts 97 and 98. As shown in Fig. 7, the lower open discharge end 79 of the supply pipe 68 is mounted in the upper end of the bore 116, and it is secured therein by any suitable means, as by welding. The upper end 80 of a nozzle tube or pipe 81 is mounted in the lower end of the bore 116, and it is secured in place by any suitable means, as by welding, to the aforementioned electric eye mounting block structure. As shown in Fig. 7, the lower end of the nozzle tubular heating chamber member 91 is enclosed by an end wall, which has a hole formed therethrough, and which is surrounded by an axial integral flange 90 which surrounds the lower discharge end 82 of the nozzle pipe 81.

As shown in Figs. 7 and 8, the discharge nozzle 13 is vertically disposed in an elongated sterile hood 15, which includes a flat, elongated upper end wall 89 that is integral at its outer ends with a pair of downwardly and vertically disposed side walls 88. As shown in Fig. 7, the nozzle tubular heating chamber member 91 is mounted through an opening 83 in the hood upper end wall 89, and it is secured thereto by any suitable means, as by welding. As best seen in Fig. 1, the hood 15 includes a sloping, inwardly extended lower end wall portion 87 which is integral with the lower end on each of the hood side wall portions

88, and which terminates in a spaced apart position close to the travel path of the containers 14 as they pass through the elongated hood 15. A vertical flange 86 is integrally formed on the lower, inner end of each of the hood wall lower end portions 87. As shown in Fig. 8, the front end of the sterile hood 15 includes a transverse wall 85 which would be disposed above the travel path of containers 14 entering the hood 15. The numeral 130 in Fig. 8 designates support structure for mounting the hood 15 in its operative position in a packaging machine.

As shown in Fig. 8, the discharge nozzle tubular heating chamber member 91 is provided with a side opening 92 in which is mounted a hot air supply conduit or pipe 93 for admitting hot air into the interior of the chamber 91 to maintain the nozzle pipe 81 at a desired temperature. The conduit 93 is secured to the tubular chamber wall 91 by any suitable means, as by welding. A suitable air valve 95 is mounted in the conduit 93 for controlling the flow of heated air therethrough. A control shaft 96 is attached to the flow valve 95, as shown in Fig. 9, for operating the valve 95. The heated air supply conduit 93 is attached, as by welding, at its outer end to a heated blower air source 94 for supplying heated air under pressure to the conduit 93. The hot air supplied by the conduit 93 is adapted to maintain the pipe 81 of the discharge nozzle 13 at a temperature above the temperature of the room in which the packaging machine is mounted. The air admitted by the conduit 93 is kept above the room temperature, such as 180°F., so as to prevent any coalescence of the hydrogen peroxide fine particles back into drops. As shown in Fig. 6, a plurality of vertical bores 100 is formed through the electric mounting block structure formed by the parts 97 and 98, so as to admit hot air upwardly into the cover 78 to heat the discharge end of the supply pipe 68.

As shown in Fig. 7, the electric eye means 99 includes a conventional electric eye sensor 102 and a conventional electric eye diode 105. The sensor 102 is threadably mounted in a suitable threaded bore in a mounting

block 103 and it is secured in position by a lock nut 128. The mounting block 103 is seated in a suitable stepped bore in the side of the electric eye mounting block structure. The stepped bore in which the block 103 is mounted communicates with the axial bore 116 in the electric eye mounting block structure. The sensor 102 extends outwardly through an opening 104 formed through the cover 78, and it is connected by a suitable conductor 108 to the electrical control unit 12. The electric eye diode 105 is threadably mounted in a mounting block 106 which is mounted in a suitable stepped bore in the electric eye mounting block structure at a position in alignment with the sensor 102. The diode 105 is secured in place by a suitable lock nut 129. The stepped bore in which the diode mounting block 106 is mounted also communicates with the axial bore 116 in the electric eye mounting block structure. The diode 105 is connected by a suitable conductor 109 to the electrical control unit 12.

As shown in Fig. 7, the discharge end of the pipe 68 is spaced apart from the inlet end 80 of the nozzle pipe 81, whereby the fine particles of hydrogen peroxide carried by the carrier air between said pipes must pass between the electric eye sensor and diode, whereby the flow rate of the hydrogen peroxide particles can be monitored. It will be understood that the electric eye diode 105 sends a light beam to the electric eye sensor 102, and that the amount of light picked up by the sensor 102 is fed back into the electrical control 12 and a read-out commensurate with the rate of flow of the fine particles of hydrogen peroxide is shown on the calibrated flow meter 110 on the front of the electrical unit 12. The fine particles of hydrogen peroxide create what might be called a fog that passes from the pipe 68 down into the nozzle pipe 81, and when there is no fog going into the nozzle pipe 81, the total or complete light emitted by the diode is picked up by the sensor, and such a situation shows an initial or base reading on the meter. As the fog is increased inside of the pipe 68, as it passes into the pipe 81, the amount of light picked up by the sensor

102 is reduced and, accordingly, the current to the calibrated meter 110 is reduced, and a different reading is shown on the meter 110. Accordingly, it will be seen that the meter 110 can be calibrated over the entire range of hydrogen peroxide particle flow, and that, when the needle of the meter 110 is within a certain optimum range, then the operator knows he is getting the proper flow of hydrogen peroxide particles. The numerals 111 and 112 designate suitable control knobs for controlling the flow of current to the electric eye 99 and to the transducer 31, respectively. It will be understood that any suitable electronic control units may be employed as, for example, the electronic control unit disclosed in the aforecited prior art DeVilbiss apparatus. The numeral 113 designates a current meter employed in the circuit of the transducer 31 for controlling the flow of current to the transducer 31.

In operation, the nebulizer 10 is actuated and the containers 14 are conveyed through the hood 15 with their open upper ends in close position under the lower end 82 of the nozzle pipe 81. As shown in Fig. 1, the fine particles of hydrogen peroxide 115 are sprayed into the open end of the container 14, and as the container is conveyed through the hood 15, the hydrogen peroxide particles dry before the carton is filled. The pressure of the carrier air may be of any suitable value as, for example, 6 psi. The monitor unit 12 permits the operator to constantly maintain a desired rate of flow of the hydrogen peroxide particles as, for example, 4 cc per minute, 8 cc per minute, or 11 cc per minute, as required. The control unit 12 provides a continuous read-out. The control unit 12 assures that the containers 14 are filled with H_2O_2 fog as they pass through the hood 15. The nebulizer 10 provides a much smaller particle size bactericide than heretofore possible with the prior art devices. For example, the nebulizer 10 is capable of providing fine particles of hydrogen peroxide down to about 5 microns size. The transducer 31 is energized by high frequenc: electric power of about 1.3 megahertz. However, it will be understood that other frequencies may be employed. The attaining of the advantage of the fine particles of about 5

microns size, and the increased output is provided by the disposing of the transducer 31 directly in contact with the hydrogen peroxide 20, whereby the vibrating energy of the transducer 31 is directly transferred into the hydrogen peroxide without having to go through an intermediate medium or element.

Figs. 10 through 14 illustrate a second embodiment of the invention in which the discharge nozzle is heated with an electrical heating means instead of a hot air heating means. The parts of the second embodiment of Figs. 10 through 14 which are the same as the first embodiment of Figs. 1 through 9, have been marked with the same reference numerals followed by the small letter "a". As shown in Figs. 10, 11 and 13, the cover 78a is square in cross section instead of round as in the first embodiment. The square shaped cover 78a is secured to an electric eye block 126 by suitable machine screws 117. The electric eye mounting block 126 is formed from a pair of mating block members similar to the first embodiment. However, it will be understood that any suitable mounting block structure may be employed. As shown in Fig. 13, the supply pipe 68a is disposed in the electric eye mounting block 126 with its discharge end 79a in a spaced apart position from the entrance end 80a of the nozzle pipe 81a. It will also be seen that the electric eye 99a functions in the same manner as in the first described embodiment.

As shown in Fig. 11, the electric eye mounting block structure 126 is provided with a chamber 118 which has an opening 125 through the side thereof. A conduit fitting 123 is threadably mounted in the opening 125, and it carries a conduit 124 for conducting a plurality of conductors 122 for a pair of electrical heaters 121. The electric heaters 121 are elongated, and are operatively mounted in a pair of suitable, longitudinal, spaced apart bores 127 which are formed in a discharge nozzle and heater mounting block 120. The electric heaters 121 may be of any suitable type as, for example, heaters sold by the E. L. Wiegand Division of Emerson Electric Co. under the trademark "CHROMALOX", model

PCN 137138 and model PCN 265498. As shown in Fig. 11, the upper end of the block 120 is seated in a recess 101a in the electric eye mounting block 126, and they are secured thereto by any suitable means, as by welding. The hood 15a is welded to a rectangular sleeve 131 which is secured by a pair of suitable mounting bolts 119 to the electric eye mounting block structure 126.

It will be understood that the embodiment of Figs. 10 through 14 functions in the same manner as previously described hereinbefore for the embodiment of Figs. 1 through 9, with the exception that the nozzle pipe 81a is electrically heated instead of being heated by hot air.

While it will be apparent that the preferred embodiments of the invention herein disclosed are well calculated to achieve the results aforestated, it will be appreciated that the invention is susceptible to modification, variation and change.

What is claimed is:

1. In an apparatus for applying a bactericide aerosol to a container for sterilization of the container, the combination comprising:

(a) a nebulizer including a body portion having a closed nebulizing chamber for holding a predetermined amount of a liquid bactericide;

(b) a piezoelectric transducer operatively mounted in said nebulizing chamber for direct contact with the liquid bactericide in said chamber, and being energizable by a high-frequency electrical power supply for generating vibrational energy and transmitting it directly to the liquid bactericide to atomize it into fine particles;

(c) an exhaust pipe mounted in said nebulizing chamber and having an inlet end disposed over the liquid bactericide in said chamber and an outlet end extended to the exterior of said chamber;

(d) a nozzle means for introducing bactericide aerosol into a container;

(e) conduit means connecting the outlet end of said exhaust pipe to said nozzle means; and,

(f) means for admitting carrier air under pressure into said nebulizing chamber for forming a bactericide aerosol with said fine particles of bactericide and for conveying said bactericide areosol to said nozzle means for introducing into a container.

2. An apparatus for applying a bactericide aerosol as defined in claim 1, wherein:

(a) said transducer is centrally disposed in said nebulizing chamber.

3. An apparatus for applying a bactericide aerosol as defined in claim 2, wherein:

(a) said inlet end of said exhaust pipe is disposed centrally in said nebulizing chamber in alignment with said transducer and spaced apart from said liquid bactericide.

4. An apparatus for applying a bactericide aerosol as defined in any one of claims 1, 2 or 3, wherein:

(a) said means for admitting carrier air is disposed above the inlet end of said exhaust pipe.

5. An apparatus for applying a bactericide areosol as defined in claim 4, including:

(a) a liquid bactericide reservoir means connected to said bactericide chamber for supplying a liquid bactericide to said chamber.

6. An apparatus for applying a bactericide aerosol as defined in claim 5, wherein:

(a) said liquid bactericide reservoir means includes a level control means for controlling the level of liquid bactericide in said chamber.

7. An apparatus for applying a bactericide aerosol as defined in claim 4, including:

(a) means for heating the nozzle means.

8. An apparatus for applying a bactericide areosol as defined in claim 7, wherein:

(a) said means for heating the nozzle means comprises a hot air means.

9. An apparatus for applying a bactericide aerosol as defined in claim 7, wherein:

(a) said means for heating the nozzle means comprises an electric heater means.

10. An apparatus for applying a bactericide aerosol as defined in claim 7, including:

(a) monitoring means for monitoring the flow rate of bactericide aerosol flowing through the nozzle means.

11. An apparatus for applying a bactericide aerosol as defined in claim 10, wherein:

(a) said monitoring means includes an electri eye means disposed across the flow path through said nozzle means.

12. An apparatus for applying a bactericide aerosol as defined in claim 10, including:

(a) a safety switch operatively mounted in said bactericide chamber for operation when the liquid bactericide in said chamber falls to a predetermined level

to shut down said apparatus.

13. An apparatus for applying a bactericide aerosol as defined in claim 10, including:

(a) an overflow drain means connected to said chamber.

14. A method of applying a bactericide aerosol to a container for sterilization of the container comprising the steps of:

(a) providing a nebulizing chamber for holding a quantity of liquid bactericide;

(b) vibrating the liquid bactericide directly with a piezoelectric transducer to nebulize the liquid bactericide into fine particles; and,

(c) conveying the fine particles of bactericide by a carrier air to form a bactericide aerosol for conveying the aerosol to a nozzle means for introducing into a container for sterilizing the container.

AMENDED CLAIMS
(received by the International Bureau on 22 October 1979 (22.10.79))

1. In an apparatus for applying a bactericide aerosol to a container for sterilization of the container, the combination comprising:

(a) a nebulizer including a body portion having a closed nebulizing chamber for holding a predetermined amount of a liquid bactericide;

(b) a piezoelectric transducer operatively mounted in said nebulizing chamber for direct contact with the liquid bactericide in said chamber, and being energizable by a high-frequency electrical power supply for generating vibrational energy and transmitting it directly to the liquid bactericide to atomize it into a pyramid type configuration of fine particles;

(c) an exhaust pipe mounted in said nebulizing chamber and having an inlet end disposed centrally in said chamber and an outlet end extended to the exterior of said chamber such that said pyramid type configuration of fine particles is disposed within said inlet end;

(d) a nozzle means vertically oriented over the path of said container for introducing bactericide aerosol into said container;

(e) conduit means communicating between the outlet end of said exhaust pipe and said nozzle means;

(f) means for admitting carrier air under pressure downwardly into said nebulizing chamber and around the lower end of said inlet end and hence around the pyramid type configuration of fine particles of bactericide for forming a bactericide aerosol with said fine particles and for conveying said bactericide aerosol to said nozzle means for delivery to said container; and

(g) electric eye means operatively connected across said nozzle means for monitoring the flow rate of bactericide aerosol flowing through said nozzle means into said container.

2. An apparatus for applying a bactericide aerosol as defined in claim 1, including a liquid bactericide reservoir means operatively connected to said bactericide chamber for supplying a liquid bactericide to said chamber.

3. An apparatus for applying a bactericide aerosol as defined in claim 1, wherein said liquid bactericide reservoir means includes a level control means for controlling the level of liquid bactericide in said chamber.

4. An apparatus for applying a bactericide aerosol as defined in claim 1, including means for heating the nozzle means.

5. An apparatus for applying a bactericide aerosol as defined in claim 4, wherein said means for heating the nozzle means comprises a hot air means.

6. An apparatus for applying a bactericide aerosol as defined in claim 4, wherein said means for heating the nozzle means comprises an electric heater means.

7. An apparatus for applying a bactericide aerosol as defined in claim 1, including a safety switch operatively mounted in said bactericide chamber for operation when the liquid bactericide in said chamber falls to a predetermined level to shut down said apparatus.

8. An apparatus for applying a bactericide aerosol as defined in claim 3, including an overflow drain means connected to said chamber.

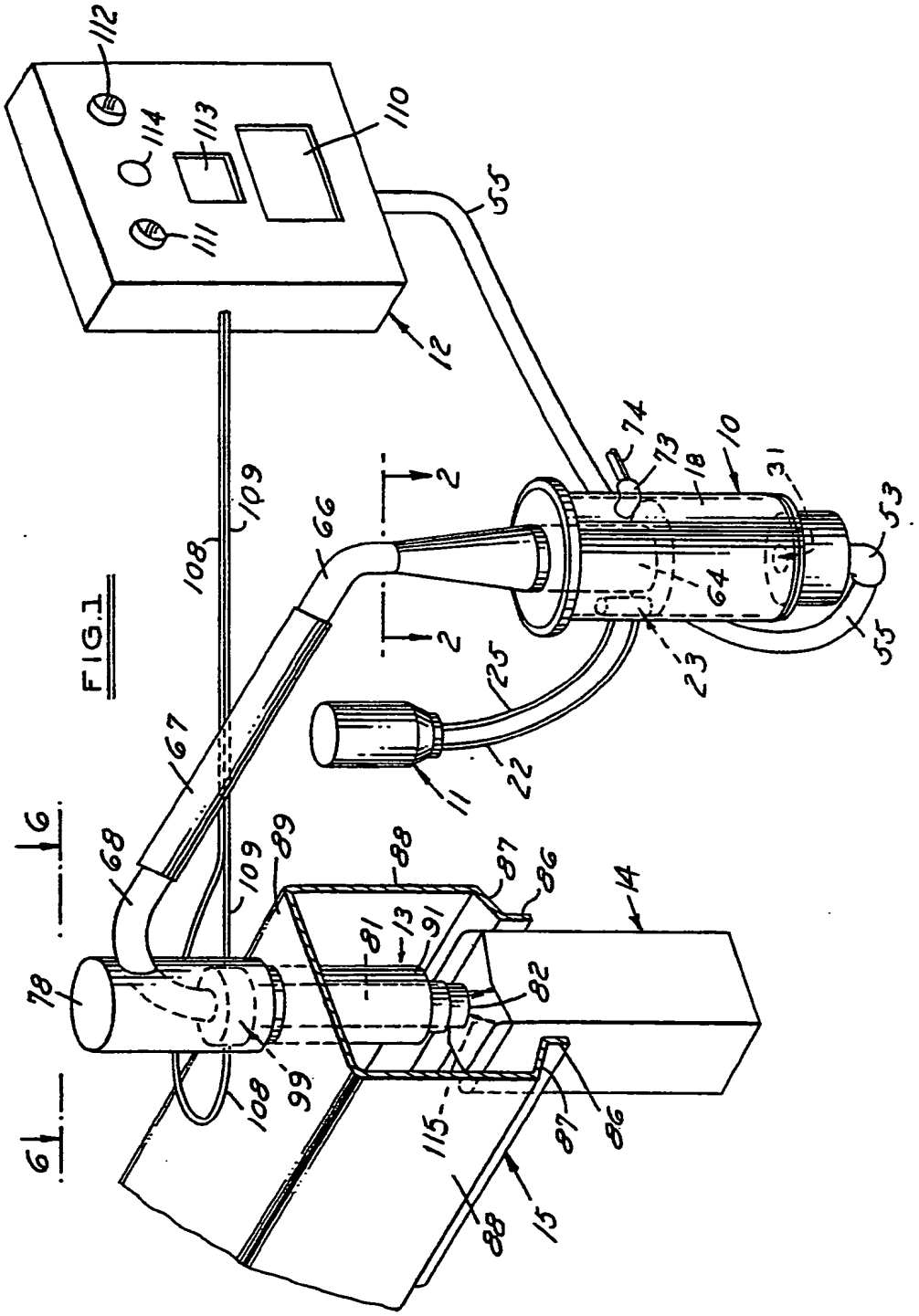


FIG.1

FIG. 2

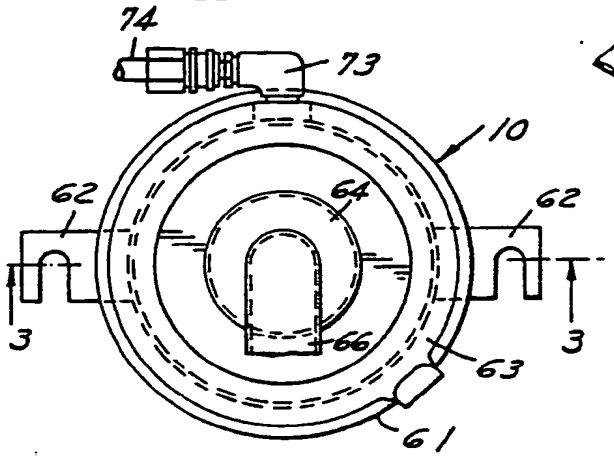


FIG. 3

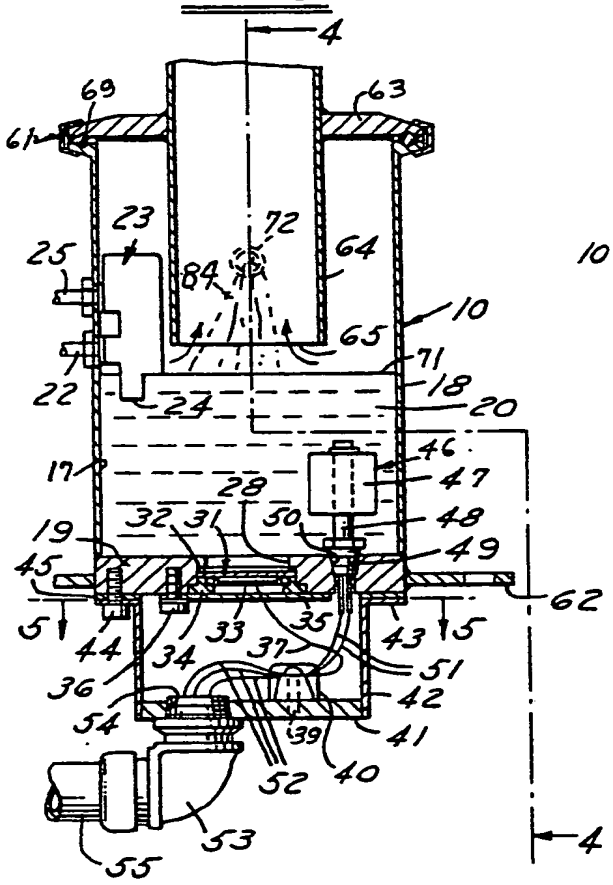


FIG. 4

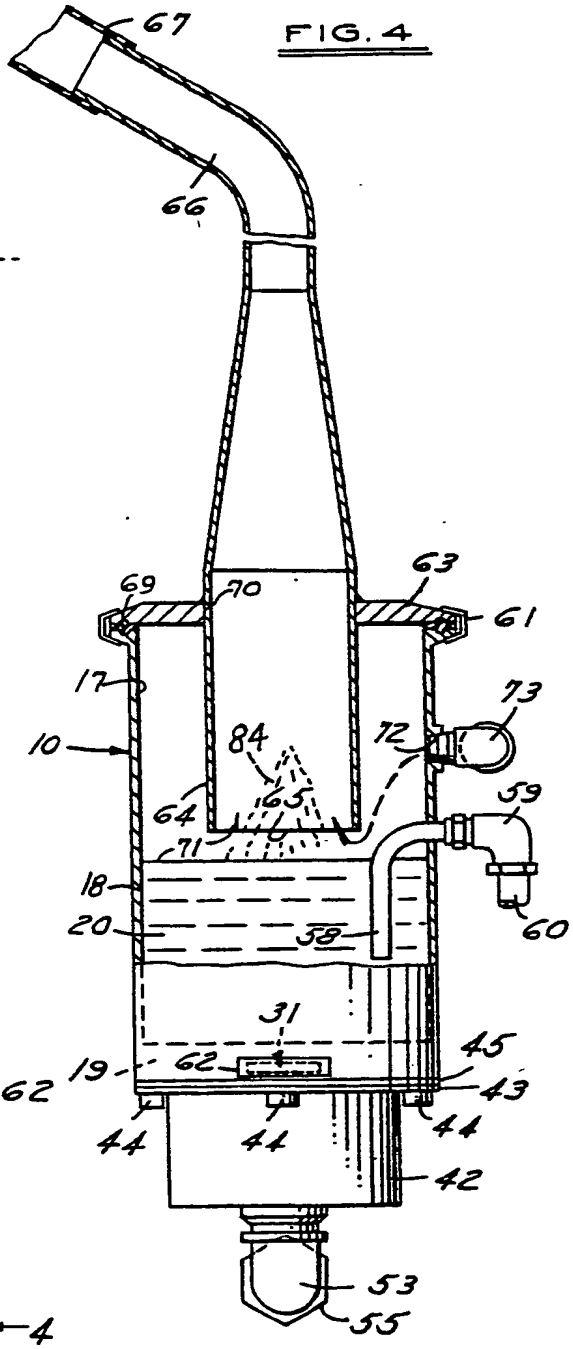


FIG.5

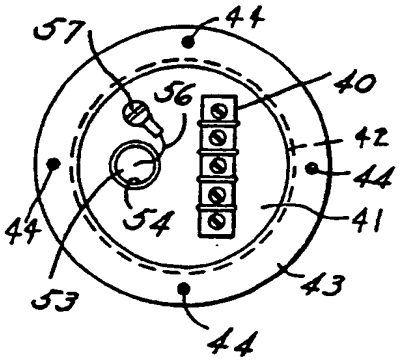


FIG.6

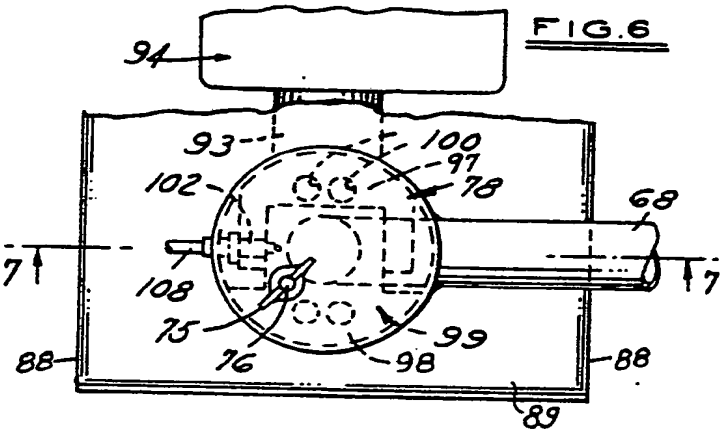


FIG.8

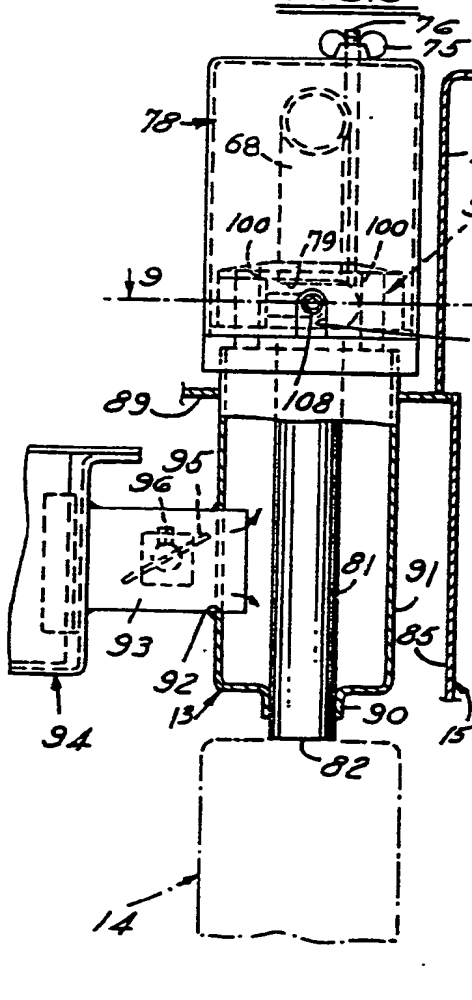


FIG.7

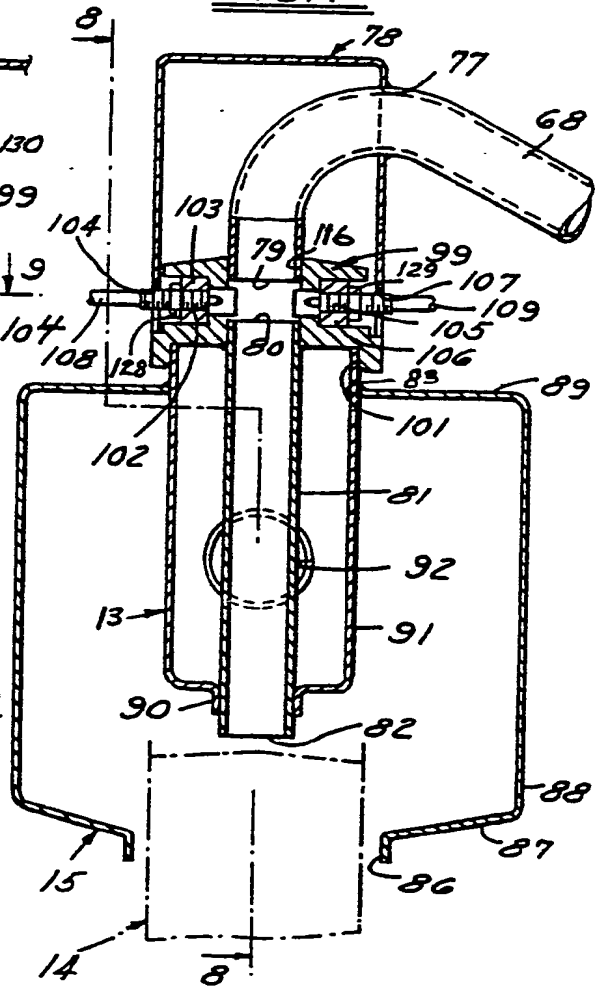


FIG.9

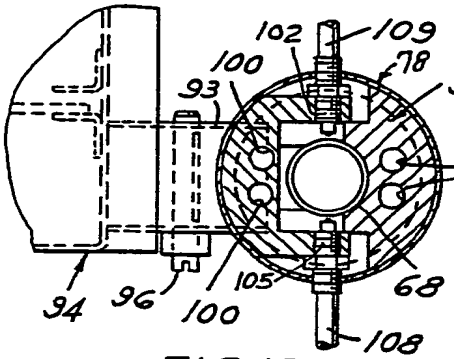


FIG.10

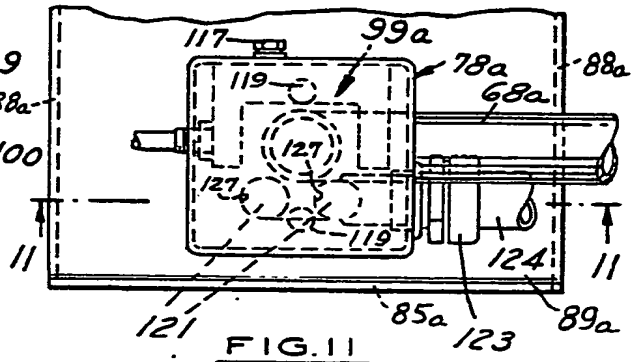


FIG.13

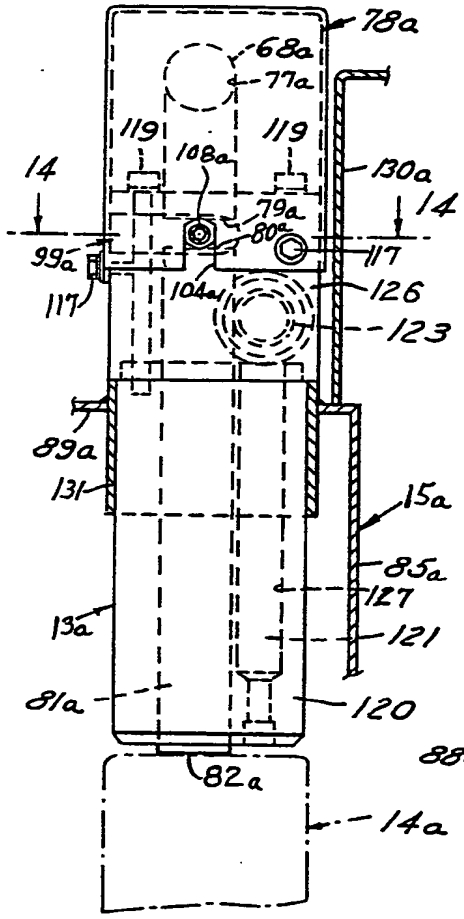


FIG.11

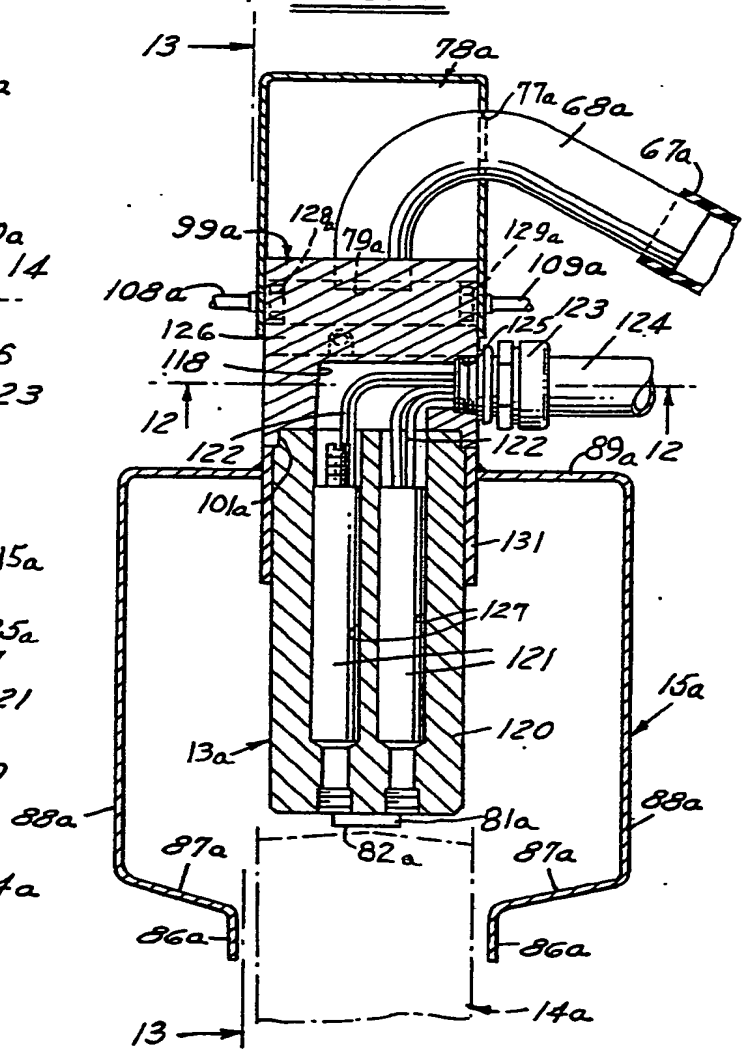


FIG.12

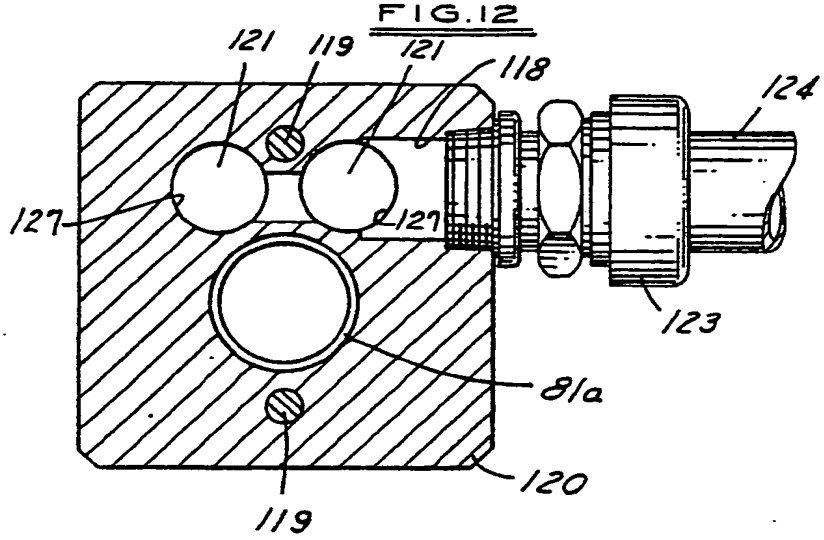
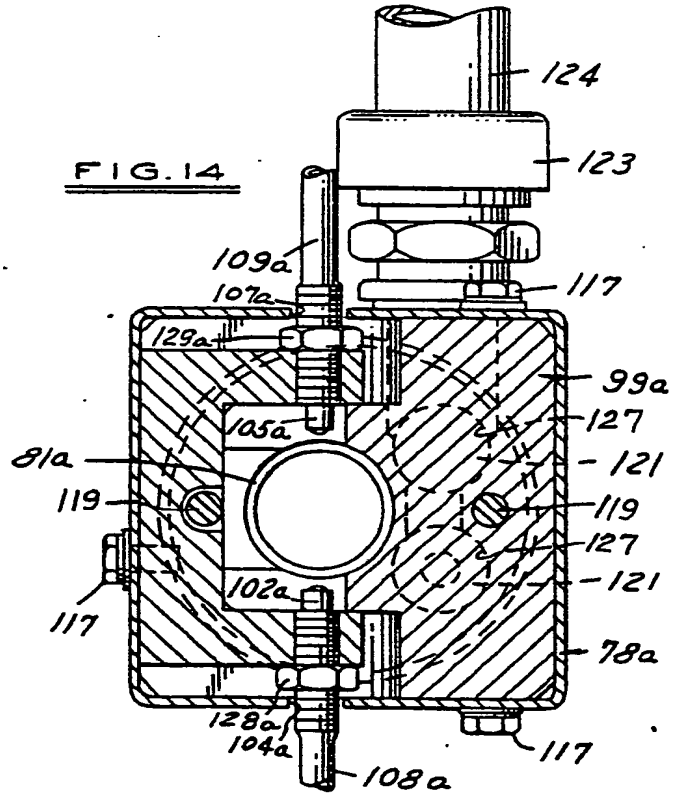


FIG.14



INTERNATIONAL SEARCH REPORT

WO 79/01074

International Application No PCT/US79/00300

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [3]

According to International Patent Classification (IPC) or to both National Classification and IPC

INT. CL. A61L 1/00,3/00; A61M 11/06; B05B 13/02,06, 17/06
U.S. CL. 422/28,106,119,292,306; 261/81,DIG. 48; 239/102,338,372

II. FIELDS SEARCHED

Minimum Documentation Searched [4]

Classification System	Classification Symbols
U.S.	422/20,28,119,128,292,302,306,106;261/78A,81,DIG. 48; 239/102,338,372;356/436,437,438

Documentation Searched other than Minimum Documentation to the Extent that such Documents are included in the Fields Searched [5]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [14]

Category *	Citation of Document, [16] with indication, where appropriate, of the relevant passages [17]	Relevant to Claim No. [18]
X	US,A, 3,387,607, published 11 JUNE 1968, GAUTHIER et al.	1-14
X	US,A, 3,723,060, published 27 MARCH 1973, LISIECKI.	1-14
X	US,A, 4,031,171, published 21 JUNE 1977, ASAO et al.	3-6
X	US,A, 3,828,773, published 13 AUGUST 1974, BUCH et al.	7-9
X	US,A, 4,018,534, published 19 APRIL 1977, THORN et al.	10-13
X	US,A, 2,828,231, published 25 MARCH 1958, HENRY.	13
A	US,A, 3,481,689, published 02 DECEMBER 1969, ROSDAHL et al.	1-14
A	US,A, 3,901,443, 26 AUGUST 1975, MITSUI et al.	1-14

* Special categories of cited documents: [15]

"A" document defining the general state of the art

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"L" document cited for special reason other than those referred to in the other categories

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but on or after the priority date claimed

"T" later document published on or after the international filing date or priority date and not in conflict with the application, but cited to understand the principle or theory underlying the invention

"X" document of particular relevance

IV. CERTIFICATION

Date of the Actual Completion of the International Search [2]	Date of Mailing of this International Search Report [2]
15 AUGUST 1979	20 AUG 1979
International Searching Authority [1]	**Signature of Authorized Officer [20]**
ISA/US	BRADLEY R. GARRIS

Form PCT/ISA/210 (second sheet) (October 1977)